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ABSTRACT

The Teaching and Learning with Technology Project was funded by Oakland Schools, Oakland County (Michigan), in 1987 to bring together in an elementary school those technologies that will be key components of schools in the future with an instructional program designed to prepare students for the information age. The project had the following objectives: (1) to explore and identify classroom applications for educational technologies such as microcomputers, instructional television, videodiscs, CD-ROM, and telecommunications; (2) to design staff development programs to assist teachers in making effective use of technology to accomplish curricular objectives; and (3) to study the impact of technology on teaching and learning. The project focused on third, fourth, and fifth grade classrooms in one elementary school over a 3-year period; data was collected by classroom observation, interviews, and achievement tests. Results of comparisons between treatment and control classrooms indicated that the classrooms differed in the amount of technology available, number of technologies used, and ways in which technology was used to meet curricular objectives. The overall results of the experimental program were favorable. Appendices contain questionnaires, achievement test scores, a word checklist, a teacher survey instrument, statistical data, and 11 case studies of participating students. A separately published "Executive Summary" has been appended. (9 references) (DB)

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Teaching and Learning with Technology

Evaluation Report

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Teaching and Learning with Technology

Evaluation Report

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Teaching and Learning with Technology Evaluation Report

Introduction

The Teaching and Learning with Technology Project was funded by Oakland Schools in 1987 to bring together in an elementary school those technologies that will be key components of schools in the future with an instructional program designed to prepare students for the information age. Spring Mills Elementary School in the Huron Valley School District in Milford, Michigan was identified as the site for a pilot project that would enable personnel from both the local school district and Oakland Schools to accomplish the following three objectives:

- Explore and identify appropriate classroom applications for technologies such as microcomputers, instructional television, videodiscs, CD ROM, and telecommunications.

- Design staff development programs that result in the effective use of technology to accomplish curricular objectives.

- Study the impact of technology on teaching and learning.

The project focused on third, fourth and fifth grade classrooms within Spring Mills Elementary School. In Fall 1987 one class at fourth grade and one class at fifth grade were selected to serve as a Teaching and Learning with Technology (TLT) classroom. In January 1988 a third grade class was designated a TLT classroom. Students in the three classrooms progressed in subsequent years to the TLT classroom at the next grade level.

In Spring 1990 the first group of students to complete three years in the TLT program graduated to middle school. The evaluation of the program reported herein was conducted with a primary focus on this first three-year TLT cohort while including information obtained from students over the past three years who were in the program less than three years.

Evaluation Questions

Questions and subquestions posed for the study of the Teaching and Learning with Technology Project include:

1. In a technology-rich environment, how is the technology applied to enhance educational goals?

   a. What technologies and software/technology-related instructional materials are used in the classroom?

   b. How are these technologies used in the classroom to meet curricular objectives?

   c. How effective is the application of technology to the writing process in improving student writing?

2. What kinds of staff development programs result in the effective use of technology to accomplish curricular objectives?

   a. How much training in the use of the various technologies is necessary? What methods seem most effective? What do teachers need to know?

   b. How has the TLT project influenced the local district's staff development program?

   c. How has the TLT project influenced the curriculum of the Huron Valley School District?

   d. What has Oakland Schools learned about staff development for teachers in a technology-rich environment that will enable its staff to provide better services to other teachers/districts in Oakland County?

3. What is the impact of a technology-rich environment on teaching and learning?

   a. How does teaching style change when a teacher moves from a technology-poor to a technology-rich environment?

   b. How does a teacher's role in the classroom differ in a technology-rich environment from a teacher's role in a technology-poor environment?

   c. What knowledge and skills do teachers report gaining as a result of being in a technology-rich environment for the past three years?

   d. How does being in a technology-rich environment affect teacher attitudes?

e. Do technology-rich environments help to increase students' achievement test scores as measured on standardized tests?

f. Does being in a technology-rich environment enhance students' reasoning skills?

g. How does being in a technology-rich environment affect student attitudes toward school and peers?

Methodology

To determine the difference technology can make on student achievement, reasoning and attitudes, this study combined an inferential approach with classroom observation, interview data and self-report to reveal the characteristics of the teaching-learning process in technology-rich environments. Particular emphasis was placed on the improvement of writing quality.

Context of the Study

The initiating agency for the Teaching and Learning with Technology Project was Oakland Schools, an intermediate school district serving the 28 local school districts within Oakland County, Michigan. As a cooperative endeavor of the Language Arts and Computing and Technology departments, the focus of the project was defined as the bringing together in one elementary school those technologies that will be key components of schools of the future with an instructional program designed to prepare students for the information age. The major focus of the instructional program was the use of word processing in writing.

In the spring of 1987 local school districts throughout Oakland County, Michigan were invited to apply for participation in a three-year developmental project in the use of current electronic technologies to support instruction and student achievement. It was clearly stated that only one school would be selected to participate. The school chosen was Spring Mills Elementary School in the Huron Valley School District.

The Huron Valley School District, in the western part of Oakland County, is a rapidly developing area. Initially a farming area centering around the town of Milford, it is now a region of new home developments and overcrowded schools. Spring Mills School was built in 1975. It is designed for the open spaces concept with wall-less classrooms clustered around centrums, open areas that can be used for large group activities. This encourages teachers to work together and permits the free flow of students engaged in a variety of activities. Students in the school are mainly drawn from the local housing developments, but at a distance that requires transportation to be provided.

The TLT Project began in Fall 1987. A technology-rich environment was created in one fourth grade classroom and one fifth grade classroom of the Spring Mills Elementary School. The classrooms selected are contiguous and have minimal boundaries between them. In January 1988, a technology-rich environment was established in a third grade classroom located in another "pod" of the building.

A technology-rich environment was defined as a classroom that had a two to one student to computer ratio at the fourth and fifth grade levels and a three to one student to computer ratio at the third grade level. Each fourth and fifth grade TLT teacher had a work station consisting of an Apple IIGS, a 20 megabyte hard disk drive, a printer, a modem, a phone line, a videodisc player, a VHS video cassette recorder and a large television monitor. The third grade TLT teacher's work station contained an Apple IIGS, a 20 megabyte hard disk drive, a printer, a large-screen television monitor and a VHS type VCR.

Technology-poor, conventional classrooms generally had two computers for 25-30 students and access to video.

Participants

Students identified for inclusion in the technology-rich classrooms were assured that placement in these classrooms would be sequential until they graduated from the school at the end of fifth grade. For example, a student in the third grade TLT classroom in 1987-1988 would progress to the fourth grade TLT classroom and then the fifth grade TLT classroom. Students selected for the fourth and fifth grade TLT classrooms were a heterogeneous group representative of their grade-mates in the school. Students were selected for the TLT classrooms in the same manner that students were traditionally placed in the school. Thus, the students upon which this evaluation focuses are representative of graduates of the school.

Similarly, teachers of the TLT classrooms remained constant over the three years of the project. The teachers chosen for the fourth and fifth grade classrooms had previous experience in using computers in their classrooms. The third grade teacher was a novice computer user.

One technology-poor classroom at each of the three grade levels was identified as the TLT control group. Students in these classrooms at the third, fourth and fifth grade levels remained in technology-poor classrooms, but may not have remained in the control group for the evaluation study. Teachers in the three control group classrooms, however, were the same for the duration of the project.

Staff Development

A second variable was introduced into the technology-rich classrooms — staff development. Staff development for TLT teachers was on-going throughout the project. It had seven components which are explained below.

Keyboarding was seen as a skill that would facilitate use of the computer for writing. Thus, early in the project a keyboarding workshop was held so that teachers would be familiar with strategies for teaching keyboarding, particularly the *Type to Learn* program. This training was done by a vocationally-certified teacher of typing.

Additional computer software and videodisc ***demonstrations*** were provided by Computing and Technology staff, Oakland Schools. Members of this group provided support and assistance to TLT teachers as they integrated these tools into instruction.

An Oakland University professor of writing served as a ***writing consultant in residence***. Visiting the classrooms frequently, he was a participant observer over the three year period. Through his support activities he modelled ways to facilitate student writing and the writing process. He worked closely with the third grade treatment group and more as an observer of the fourth and fifth grades.

Two workshops per year were held on ***change facilitation and program evaluation***. These workshops were attended by the TLT teachers, the building principal, the assistant superintendent for curriculum, and Oakland Schools staff. Since changes in teacher and student roles and teaching styles were hypothesized for the TLT participants it was considered important that those middle school teachers who would receive the students be involved in this process. Thus, the middle school principal and the teacher block team to which the students would be assigned were encouraged to participate as well.

Monthly ***TLT team meetings*** provided opportunities for TLT teachers, the building principal, district administrators, and Oakland Schools staff to share their perceptions of changes that were occurring and to receive support for their work. It was a chance, too, for staff to assess project needs and ways to meet those needs. Thus, change was not encouraged in a vacuum, but with support for participants experiencing these changes first-hand.

The TLT teachers and the district administrative staff made a four-year commitment to participate in a series of county-wide discussions related to the role of technology in the restructuring of schools. Facilitating these ***discussions and visitations*** were nationally recognized experts — Dr. Christopher Dede, Center for Interactive Educational Technology, George Mason University; Dr. Lewis Rhodes, American Association of

School Administrators; and Robert Pearlman of the American Federation of Teachers.

In addition, an open invitation was given for TLT teachers to attend ***Oakland Schools-sponsored workshops and events*** related to the technology needs of the teachers. They attended regularly scheduled workshops and special programs like the desktop video production training provided by Fred D'Ignazio.

Less intensive training was available to other teachers in Spring Mills Elementary School. Instructional inservice was done in the building for these teachers by the TLT teachers. They had access to, and many of them participated in, assorted technology-related inservice programs sponsored by the Huron Valley School District and Oakland Schools.

Procedures

Having established the technology-rich environments in the three classrooms and provided training in keyboarding, the teachers exercised leadership in determining effective means of using the technology in the instructional program. Support was provided as needed and direction/ structure was arrived upon collaboratively in team meetings. The Oakland Schools staff acted in a facilitative role so as to observe the changes in teaching and learning that might occur in this new environment while being responsive to teachers' needs.

Data Collection and Analysis

At the beginning of the project interviews were conducted with all students in the technology-rich classrooms (the treatment group). The objective of the interviews was to assess students' prior experience with computers at school and at home, knowledge of computers, perception of the importance of computers, and attitude toward school.

An exit interview with the treatment group that participated in the project for three years was held in Spring 1990. The interview schedule was designed to parallel the one used for the entrance interview. Emphasis was placed on computer use at home and at school, how using a computer has changed the way work is done in school, and changes in the roles of teachers and students. (Both interview instruments are contained in Appendix A.)

Exit interviews were also held with the fifth grade control group.

Data from the interviews were tabulated and analyzed using descriptive statistics. Comparisons between groups were made using the chi-square statistic, where appropriate. Each year of the project two other

measures were used to assess differences between the treatment and control groups on language arts variables. The Gates MacGinitie Reading Test provided scores on vocabulary, reading comprehension and a total reading score. Validity data for the test is not reported although care has been exercised in its construction to ensure content validity. The test is considered highly reliable; the Kuder-Richardson Formula 20 coefficients for internal reliability range from .90 to .93 for the vocabulary subtest and from .88 to .91 for the comprehension subtest. Each fall and spring this test was administered to the treatment and control groups by their classroom teachers.

Comparisons of the groups' mean scores on the vocabulary subtest, reading comprehension subtest and total reading score were carried out each year using an analysis of covariance. The fall score served as the covariate.

Similarly, at the beginning and end of each academic year TLT and non-TLT students responded to a writing prompt presented by their teachers. A different prompt was used each year, but the same prompt was used for each pretest-posttest sequence. The prompts used during the three project years are as follows:

Year 1: ***Something Special:*** Think of your life—the people and things around you. What person or thing is special to you? It might be your parents, a sister or brother, your pet, a favorite toy or friend. Why is this person or thing special? Write a paper that tells about the person or thing. Explain why the person or thing is special.

Year 2: ***Field Trip***: Imagine that your class needs to decide where to go for a field trip. You could go to a factory, hospital, nature center, zoo, museum—any place that would interest the class. Help your class decide where to go. Write a paper that suggests one place to visit. Explain why you think your class should go there.

Year 3: ***Special Person - Special Day***: If you could be someone else for a day - anyone: an actor/actress, astronaut, artist, scientist, writer, athlete, or any figure from history like a queen, king, or a kid your age who lived in the time of George Washington or any other time you might choose - who would you pick to be? Remember that you can only be this person for one day. Why would you choose to be this person? How would you spend the day? What would you choose to do? Who would you spend the day with?

Students were given several weeks to prepare their writing samples. Upon completion, the writing samples were given to Oakland Schools staff who carefully coded them and entered them into the computer as written by the students. Copies of all writing samples (fall and spring) were printed and given to a chief reader each summer. He read them, selected writing samples that were representative of 10 levels of writing quality spanning the three grade levels and established criteria for each level. He then convened a group of readers and explained the levels to

them. Two readers read each paper. If they differed by more than one level in their rating of the paper, it was read by a third reader. If two of the three readers agreed on a level, the paper was rated at that level. If agreement was not reached by two of the three readers, the mean of the three readers' ratings was agreed upon as the writing level. For those students in the project for three years, there are six writing samples. Comparisons of the writing samples between the TLT and non-TLT classrooms were made using a repeated measures analysis of variance over the three years of the project. Since there is a greater emphasis on writing in fourth and fifth grades, a repeated measures analysis of variance was done for these two years.

The Huron Valley School District uses several assessment instruments that were subsequently employed in this evaluation study. They are: the California Achievement Test administered at the third and fifth grade levels, the Test of Cognitive Skills given to third and fifth graders, and a writing competency test conducted in the third and fifth grades. Reliability and validity information on these tests is provided in Appendix B.

The fourth grade tests of the Michigan Educational Assessment Program (MEAP) were not used in the evaluation of the project for several reasons. First, they were not well-synchronized with existing district testing. Thus, comparison of these tests with other district tests is not prudent. Second, the fourth grade tests are generally given in the fall. At that time students have completed only one year in the program, a year in which the emphasis was more on keyboarding than on the writing process per se. The MEAP tests are criterion-referenced tests while the other tests used in the evaluation study are norm-referenced tests. In addition, the MEAP reading test was changed in 1988, making comparisons with earlier data impossible.

Throughout the three years of the project regular observations of the TLT classrooms were conducted by Dr. Ronald Sudol, Professor of Rhetoric at Oakland University. He kept a journal of his observations and periodically shared these with project staff in memoranda. During the third year of the project he did a series of case studies. Three or four students from each of the TLT classrooms were selected for study. The eleven students represent a range of abilities and attitudes toward learning and technology. The purpose of the case studies was to provide another way of observing and evaluating the TLT classrooms.

Student perceptions of school climate and morale were measured using the Word Check List (Appendix C) developed by Dr. Douglas Heath. This instrument was administered to all treatment and control groups by the project evaluator in May 1990. The evaluator also administered the Word Check List to all sixth grade students at Highland Middle School, the school which receives most of the graduates of Spring Mills Elementary School.

Frequency data for each word were calculated. One value represented the number of students who thought the word described their class or school. The second value reflected the number of students who wished the word described their class or school.

All teachers were requested to complete a self-report instrument in May 1990. Different instruments were used for TLT teachers and other teachers in the Spring Mills Elementary School. Both survey forms asked teachers about: the technologies they use in the classroom and how these technologies are used, their experience with computers, the computer software most frequently used in the classroom, criteria used to evaluate the effectiveness of using technology to meet curricular objectives, and how technology (especially computers) may have altered the way they teach. Additional questions asked of TLT teachers related to 1) staff development programs provided as part of the project and 2) how the TLT project has influenced curriculum in Spring Mills Elementary School and throughout the district. Non-TLT teachers were asked to: 1) identify ways having the TLT project in the school impacted them and 2) describe their personal professional development plan for the next two years. (Appendix D contains both survey instruments.)

Interviews with the TLT teachers, the assistant superintendent for curriculum, the director of staff development, and Oakland Schools staff were conducted by the evaluator.

Teacher self-report and interview data were synthesized by the evaluator to respond to the evaluation questions posed in the introduction.

Findings

How Technology Is Applied to Enhance Education Goals

Comparisons between treatment and control classrooms indicate that there are differences between the two types of classrooms on the following variables:

1) amount of technology available;
2) the number of technologies used; and
3) the way technology is used to meet curricular objectives.

Technology-rich classrooms had a two to one student to computer ratio at the fourth and fifth grade levels and a three to one student to computer ratio at the third grade level. In addition, they had available to them the following technologies: video, videodisc and computer-assisted telecommunications. Teachers and students in these classrooms employed their technology assets in a variety of ways to meet curricular objectives.

In third grade, emphasis was placed on students developing keyboarding skills and using word processing for writing assignments. The most frequently used programs at that level are *Type to Learn, Magic Slate II* (Sunburst)and *Children's Writing and Publishing Center* (The Learning Company). The teacher reports not being a computer-user when the project began, but now says, "I cannot imagine teaching writing without a word processing program."

The use of word processing was expanded in fourth grade. Students used it to identify and re-format paragraphs and/or quotations. Word processing served as a tool to format poetry, reports, headings, page numbers, etc. The culminating activity for the year was the publication of a magazine written, edited, designed, and produced by the students using desktop publishing software.

Fourth graders used their microcomputers in other ways. They participated in AT&T's Long-Distance Learning Network communicating via telecommunications with students as far away as Australia. They engaged in desktop video production using the computer, video camera and other media to produce a videotape about the project. In this endeavor, the students wrote, storyboarded, performed, and taped vignettes of school life.

Videodisc was introduced to the fourth grade as an integral part of the learning environment. The teacher designed and presented computer-controlled, videodisc-based lessons using *AppleWorks* (Claris), *ImageWorks* and *Space Archives #5: Greetings from Earth* (NASA).

Students in fifth grade used their microcomputers extensively. They were used across the curriculum in a variety of ways: writing, database project management, inquiry learning, desktop publishing, telecommunications, simulations, and programming in Logo. The key concern at this level is student independence and the acceptance of responsibility for assignments. Students were encouraged to work together on projects to meet curricular objectives. Technology served as a tool to carry out their work. They participated in the AT&T Long Distance Learning Network, produced periodic newsletters and carried out a variety of projects, including a cross-age project with kindergarten students in which they produced a book of the children's favorite Mother Goose rhymes.

The TLT teachers continually asked themselves, "Can the students use the technology as a tool to help them learn?" The teachers identified five criteria they use to evaluate the effectiveness of technology to meet curricular objectives. They are:

- Is the software easily manipulated by the students?
- Does the software grow with the students?
- Can the technology blend into the existing curriculum?
- Can the software enhance or extend a lesson?
- Does the complexity of the technology interfere with the task?

The comparison conventional classrooms generally had access to video technology and microcomputers with a fifteen to one student to computer ratio. While only two technologies were available and these were in short supply, the students and teachers nevertheless used them to forward curricular objectives. Teachers reported that they showed videotapes that related to, and extended, the curriculum. Desktop video production was also an important, but less frequent, activity. Performances by children were videotaped, edited and enhanced using the computer.

The two computers in the conventional classrooms were used extensively. Interviews with fifth grade students indicated that they most frequently used the computer to reinforce basic skills using "games" and for writing activities. Teachers in all non-TLT classrooms concurred that these were the main ways computers were used. They emphasized that writing and publishing were key computer uses that enhanced the curriculum.

Table 1 indicates how fifth grade students reported they used computers at school and at home. The TLT students reported the almost exclusive use of computers for writing and other applications (graphics, telecommunications) in school. The non-TLT students placed more emphasis on the use of computers to reinforce basic skills while using computers for writing takes second place. At home both TLT and non-TLT students used computers about equally for writing and playing games. Chi-square analyses confirmed that there is a significant difference between the two groups' use of computers in school ($x^2(13) = 54.19$, $p < .001$), but no difference between the groups' use of computers in their home environments.

Table 1
Student Reported Uses of Computers in Two Environments

Uses	School		Home	
	TLT	Non-TLT	TLT	Non-TLT
Typing	-	1	2	-
Games	-	17	10	8
Learning Games	-	3	-	-
Adventure Games	-	8	-	-
Math	-	12	1	1
Writing	25	17	10	9
Art/Graphics	7	3	-	1
Telecommunications	2	-	-	-
Simulations	2	-	-	-
Programming	1	-	-	-
Spelling	1	1	-	-
Science	2	-	-	-
Reading	-	2	-	-
Make Video	-	1	-	-

These uses of the computer at school and at home were verified by analyzing the types of programs fifth grade students report using in the two environments. Table 2 shows the number and percentage of programs and program types TLT and non-TLT students report using.

Table 2
Number and Percentage of Programs Students Use at School by Program Type

	TLT		Non-TLT	
Program Type	Number	Percent	Number	Percent
Applications	12	46	4	16
Instructional	7	27	2	8
Simulations	6	23	5	20
Programming	1	4	-	-
Drill and Practice	-	-	14	56
Total	26	100	25	100

Shown in Table 3 are the number and percentage of programs and program types that were mentioned by the students. For example, the seven instructional programs TLT students report using were mentioned 13 times, or 11% of the programs mentioned were instructional programs.

Table 3
Number and Percentage of Times Students Mention Using Each Program Type

	TLT		Non-TLT	
Program Type	Number	Percent	Number	Percent
Applications	75	65	27	32
Instructional	13	11	3	4
Simulations	26	23	12	14
Programming	1	1	-	-
Drill and Practice	-	-	42	50
Total	115	100	84	100

A pretest-posttest comparison of TLT students' uses of computers at school indicates a dramatic shift from "games," or drill and practice types of programs, to the use of applications software where the computer is used as a tool to accomplish specific tasks; i.e. writing, illustrating, telecommunicating. Table 4 shows these changes, which might be expected with the project's emphasis on employing the computer for writing and the other ways teachers report using this technology in the classroom. A chi-square test of expected frequencies indicates that the change in computer use is highly significant (x^2 (10) = 33.8, $p < .001$).

Table 4
TLT Students' Pre and Posttest Reported Uses of Computers at School*

Uses	Pre-TLT	Post-TLT
Games	18	5
Writing	11	19
Mathematics	10	-
Learning to tell time	2	-
Simulations	1	-
Vowel practice	1	-
Recordkeeping	1	-
Graphics/Drawing	-	5
Telecommunications	-	2
Complete projects	-	2
Programming	-	1

* *Data is reported for the 21 students in the program for three years.*

The TLT project focused upon the role of computers in writing when the process approach to writing is used. It was hypothesized that if computers are used effectively for writing, students' skills in writing and reading comprehension would improve when compared with non-TLT students. Also, it was suggested that vocabulary expansion would be a natural result of an increased emphasis on using computers in the writing process.

Differences in writing improvement between the TLT and non-TLT students were assessed each year by having the students write to a prompt each autumn and spring. The same prompt was used each autumn and spring, but varied from year to year. The writing samples were then ranked by writing experts (trained readers). Comparisons between the groups were made using a repeated measures design. The results indicate that while the groups were similar when they entered the program in third grade, they became more disparate each year with significant differences ($F (1,23) = 9.31$, $p < .006$) appearing at the end of fifth grade. This analysis was carried out using only those students in the TLT (N=21) and the control group (N=4) for all three years. A similar comparison of students in the two groups (N = 23 and N=11) during the fourth and fifth grade years indicates that the groups were similar at the beginning of fourth grade. They become less similar by the end of the year and were significantly different when they entered fifth grade

($F(1,30) = 4.16$, $p < .05$). This difference increased during the final year in the program ($F(1,30) = 12.07$, $p < .002$). (See Appendix E for additional statistical data.)

To test the hypotheses related to vocabulary and reading, the Gates MacGinitie Reading Test was administered to all TLT and control group students each fall and spring. Comparisons between the groups were made using an analysis of covariance, the fall test score serving as the covariate. For each of the three years of the project no differences were found between the groups at the third and fifth grade levels on the vocabulary subtest, the reading comprehension subtest or the total reading test. During the second year of the project a highly significant difference was found between the fourth grade groups on the vocabulary subtest ($F(1,32) = 11.322$, $p < .002$). This influenced the total test score, which was also significant ($F(1,32) = 5.651$, $p < .024$). (See Appendix F for additional statistical data.)

Effects of Staff Development on Curricular Objectives

When evaluating the effects of staff development on the effective use of technology to accomplish curricular objectives, four specific areas were addressed: training needed for successful classroom implementation, influences of the project on the district's staff development program, influences of the project on the district's curriculum, and findings of Oakland Schools' staff regarding teaching and learning in a technology-rich environment. A synthesis of findings from interviews and TLT teacher questionnaires follows.

Training needed for successful classroom implementation of technology. "How much training is necessary in the various technologies?" does not seem to be the best question to ask. Rather, it appears to be more appropriate to focus on the types and methods of staff development that are most effective.

TLT teachers identified a variety of staff development opportunities that were open to them: workshops sponsored by the local district and the intermediate school district, a monthly team meeting, an annual meeting to assess what has happened and where the project is headed, and on-going support from Huron Valley and Oakland School staff. While they felt that much of the real learning of the past three years was individual in nature, three aspects of the staff development program were considered critical to the success of the project. Like the students they teach, the TLT teachers felt a need for structure and direction. They found that goal setting in the team meetings and the annual assessment of project directions were critical in providing structure and direction for the project. These activities also facilitated building a cohesive TLT team that included both TLT teachers and intermediate school district staff. The third critical factor in using

technology successfully in the content areas was the teaming and support provided for the TLT teachers. One teacher expressed it as "someone on the other end of the phone." But, teaming and support went further than just gaining immediate assistance with a problem; it was the feeling TLT teachers had that they enjoyed the complete support and trust of Oakland Schools and their local school district. They felt empowered.

Technology-related training was important to the TLT teachers, but not sufficient. They reported that training they received in instructional skills development (Instructional Theory Into Practice or ITIP) and on the Michigan Definition of Reading contributed to their success in the technology-rich environment. This training provided a context into which they could incorporate the use of technology to further curricular objectives. One interviewee suggested that it takes about five years of training in writing, reading, thinking skills, cooperative learning, technology, and instructional skills for a teacher to reach the point where technology is fully and successfully integrated into the curriculum in such a manner that its use is automatic for teachers and students.

TLT influences on the district's curriculum and staff development. The TLT project has had a profound influence upon the curriculum of Huron Valley School District and the district's staff development program. These influences have been in the following areas: 1) how technology is used in the curriculum, 2) how curriculum is developed, or evolves, and 3) the role of teachers in curriculum development and staff development.

From the time the TLT project was initiated the focus was on the use of technology, specifically microcomputers, to enhance the writing program. The TLT teachers became role models for other teachers in their school and in other schools as they moved beyond "skill and drill" as the sole contribution of computers to the classroom. They emphasized the use of word processing in writing. Graphics programs also became important because students wanted to use this new tool to embellish their writing with illustrations. The graphic capabilities were further extended by adding camcorders, VCRs and video software in order to do desktop video production. Thus, like pencils, paper and paint, the computer became a versatile tool that was used across content areas to produce dynamic reports and carry out projects.

The TLT project caused the school district to re-focus on its writing program and its long-range technology plan. Word processing came to be viewed as a tool that could assist students to communicate and express their ideas creatively. The tool became necessary to the curriculum and spawned changes in the way curriculum revision usually takes place. Instead of the normal top-down approach in which middle schools respond to the demands of high schools and the elementary schools react to the demands of middle schools, change occurred increasingly from the bottom up. While it is not possible to have technology-

rich environments in all classrooms, the district revised its writing curriculum and technology plan to incorporate the use of word processing into writing and to establish a computer/writing laboratory in each elementary school. The TLT project impacted the district's thinking about spending per capita dollars and reinforced the community's belief in the power and importance of technology as an integral component of education for its youth.

Changes in the way the educational process occurred in the TLT classrooms had an effect upon the middle schools receiving the students from the project. The principals and receiving teachers became involved in the change facilitation and program evaluation workshops conducted on an annual basis. They re-evaluated their technology plans and the role of the media/computer laboratories in the schools. They found that the previously sparsely-used computer labs now had eager users. The dynamic change taking place at the elementary school level forced a rethinking of educational practice at the middle school level. Thus, the top-down organizational structure that usually enacts curriculum change has also been reversed.

Staff development in Huron Valley School District has been profoundly influenced by the TLT project. The district applied to the State of Michigan for professional development monies to fund training for teachers who would be using the writing/computer labs. In intensive summer workshops, the TLT teachers become trainers. They introduce their colleagues to: the computer, strategies for managing a technology-rich classroom, and the district's curriculum in writing, which emphasizes communications. And, from experience, they deal with the strengths, weaknesses, opportunities, and threats faced by a teacher implementing this new tool into the writing program.

But the role of the teacher in staff development has become much more than that of a trainer for a couple weeks in the summer. There is a recognition of the need for teacher support in this endeavor. Teachers within the TLT project found it valuable to share ideas, set common goals and assist each other when technical problems arose. This support network soon extended to other teachers within the school. Now there is a semi-formal, collaborative process throughout the district that provides support for teachers working to integrate technology into their classrooms. It is semi-formal in the sense that it is open to all interested teachers with leadership rotated among school buildings, but four times per year dinner meetings are held at district expense. In addition, meetings are held at least twice a year for those teachers who are interested in the technical aspects of the technology. The TLT project empowered the teachers as change agents and they are working with other change agents in the school and district-wide to achieve common goals.

Implications for staff development at the intermediate school district level. Interviews with the TLT teachers indicate that effective staff development had two important components:

- support for change from the district and school and
- a support network for teachers.

These findings are not new in the literature of staff development. They are, perhaps, even more important in the context of implementing the use of a technology-rich environment. They have implications for where and with whom intermediate school district consultants interact in a local district.

A second finding is that technology will not change a teacher. It is not a quick fix for problems in education nor will it substitute for the personal development of educational personnel. It can, however, serve as a catalyst for dynamic change in the classroom, providing that there is support for change and that the teachers are open to change. Because technology revitalizes both the teacher and the profession, it frequently makes a good teacher better. The change cycle is one fraught with ambiguity. Teachers must grow and develop skills while working in an environment of uncertainty and concern. They must have faith in and knowledge about how children learn; they must act on what they believe about students and learning. And, most importantly, they must be patient. In this process a support network becomes vital.

The TLT project served as a bridge between the on-going writing curriculum of the district and technology. The use of technology was put into a setting that made sense to the teachers. The intermediate school district may serve a vital role in assisting teachers to broaden the context for using technology; the emphasis of classes should be placed upon how and where technology can be used in the curriculum rather than on learning about technology as an end in itself.

Impact on Teaching and Learning

Teaching and learning in a technology-rich environment is not the same as in a traditional classroom, even when that classroom is in a school espousing and designed for the "open" school concept. The TLT project has changed the way teachers and students interact and work. These changes will be discussed separately for the two groups.

Effects of a technology-rich environment upon teaching and teachers. As teachers reflected on changes their teaching had undergone in the course of the project, they had the following responses:

> "Being part of the TLT project forced me to learn about computers and use them. Now I cannot imagine teaching writing without a word processing program."

> "I have relinquished control of the classroom in order to become more of a guide and give students more responsibility for their learning."

> "Technology has provided an avenue to begin to invest more responsibility for learning in the students' hands. Using technology emphasizes the importance of teaching students the process of acquiring new knowledge through a hands-on and applied approach."

While the technology-rich environment may have initially been threatening, the teachers report that they do not want to teach without technology. They see it as a powerful tool that has provided the opportunity for a different kind of structure to evolve in their classrooms. They can be omnipresent without being controlling. They see students as having more power and more responsibility for their learning and, thus, they expect students to identify and solve problems more independently. As one teacher stated, "Technology has validated the way I always thought teaching should be—project oriented and student focused."

Students in the TLT classrooms have perceived these shifts in the teacher's role. In interviews, both the TLT and non-TLT fifth grade students were asked about the roles of teachers and students. They responded that their role as students is to "learn" and "get their work done" while the role of a teacher is to "teach" and to "help students when they are stuck on a problem." These responses seem to indicate that student and teacher roles have not changed. It is when we look at the way students expressed the job of a teacher that subtle changes in the teacher's role are seen. For example, students in the TLT classroom more frequently mentioned teacher roles that were aimed at student self development—"break off our bad habits," "be a friend," "keep us from getting depressed," "motivate kids." Students in the non-TLT classroom mentioned roles that were more directive or authoritarian—"make you learn stuff," "make sure we get along good."

Changes in teacher behavior mirror changes in skills and attitudes. In addition to learning more about technology and ways it can be integrated into the curriculum, teachers report that they and their students have a greater tolerance for ambiguity and that both parties have ownership in the teaching/learning process. The project forced conscious discussion of their roles as teachers causing them to take stock of themselves and their work. Thus, they are more reflective about what they do in the classroom and seek out research to learn more about the process of education, including continuing their own formal education.

They have gained a broader view of education. It is no longer limited by the walls of their classroom; they train and provide support to their peers and take an active role in curriculum development for the district. The TLT teachers are motivated contributors. They have skills and knowledge they can, and feel they should, give back to the profession. They have been empowered as change agents with children and their colleagues.

Effects of a technology-rich environment upon learning and students. Fifth grade students were asked whether they think computers have changed the way they work in school. TLT students were almost unanimous in responding "yes." In justifying their responses they cited their preference for using a word processor versus writing with a pencil. They found it easier to write and draw, to correct errors, to be more productive, and to improve their writing skills. The use of the computer as a tool that can be controlled by the learner and applied to a variety of tasks was verified. The alternative learning situation they described would be: teacher-directed, paper and pencil oriented, frustrating because of sloppy writing, focused on basic subjects, less interesting and fewer projects. On the bright side, they saw more space in the classroom without the hardware.

The final issue of the ***D-News***, the fifth grade newspaper, had two articles written by students that are of interest for this program evaluation. The first article provides brief reflections from students on what it was like in the TLT class for three years. The following excerpts provide some perspective.

> "When I first started using the computers it was really confusing learning everything. Now, since I've been in the class so long I don't think it's as confusing as when I first started and it's more fun using the computers."
>
> "TLT has been the best experience for me. Making videos, using computers, and having special visitors was great. It was really different for a while, but now I'm used to it and it's really no big thing. Everyone should have the opportunity to be in the TLT class."
>
> "Being in the TLT class for three years was a great experience. It was also a good time with the computers, making videos. It is fun and different. TLT seemed to make work a lot easier."
>
> "To be in the TLT program for three years was a very good experience. It was much better than being in a regular classroom with the teachers explaining and you working. In the TLT program you do special projects, learn more, learn faster, and in a funner (sic) way."

> "When I first started using the computers I thought it was really weird, but now I think that when I walk in the room that I'm going to have a easy day on the computers instead of wondering if I'm going to crash a disk or something."

The second *D-News* article asks the students to project what middle school will be like without computer access throughout the entire day. Typical comments are as follows:

> "Middle school will be boring without computers to do my work on."

> "I think I'll miss them (computers) a lot. It'll be weird not using them constantly every day. Computers have changed my life forever."

> "Now most people have to improve their writing skills."

One aspect of the learning environment that has evidently become transparent to the students is the social environment; it was not mentioned by students in either the interviews with the project evaluator or in their comments reported in the class newspaper. Extensive interactions among students and between teacher and students in the TLT classrooms are a normal part of doing business. Students generally work with computer partners. Their writing is on public display and invites comments from classmates who "just happen by." Projects are conducted in cooperative groups. All of these activities foster working together in ways that are at variance with the "traditional" classroom. The computing teacher in the middle school noted this tendency to work in teams. He reported that TLT students exhibit leadership in a number of ways. They move around the classroom easily, share their ongoing work and spontaneously organize groups that work together to accomplish tasks. Generally, they are better prepared for work when they enter the classroom and are more self-directed.

The case studies (Appendix G), carried out by the "writer in residence" during the third year of the project, also address the issue of socialization. The studies of students A and B, both third graders, point out how the computer is used to focus the attention of easily distracted students. Case studies of students Q and T note how the computer served as the focal point for the students as they learned better socialization skills. Under the direction of a skillful teacher, the computer seemingly can be used to reach disparate goals — focusing the attention of distractible students and expanding the horizons and socialization of other students.

The non-TLT students were split in their responses about whether the computer has changed the way they work in school. They saw the computer more as a delivery system that could provide instruction and

improve skills than as a tool they could use for writing and other applications. With the disappearance of the few computers in their classroom they viewed school as going on normally although they might have to write more and they would miss having computer time.

Huron Valley School District's testing program for third and fifth grade students includes the administration of a writing competency test, the California Achievement Test and the Test of Cognitive Skills. Analyses of variance were used to compare the scores of the TLT and non-TLT students on the fifth grade tests. No differences between the groups were found on the district writing competency test; the vocabulary, comprehension or total reading score of the California Achievement Test; and the Test of Cognitive Skills.

These tests were correlated with the writing tests used for the evaluation of the TLT Project. Table 5 indicates that there is a high correlation between all of the tests for fifth grade students.

Table 5
Correlation Coefficients for Fifth Grade Testing Program

Test	District Writing	CAT-Vocab	CAT-Comp.	CAT-Rdg. Tot	Cognitive Skills	TLT Writing. Fall 89	TLT Writing. Spr. 90
Writing	1.000	.554**	.569**	.602**	.515**	.561**	.459**
CAT-Vocab.	.554**	1.000	.773**	.946**	.725**	.461**	.372**
CAT-Comp.	.569**	.773**	1.000	.935**	.704**	.479**	.428**
CAT-Rdg. Total	.602**	.946**	.935**	1.000	.759**	.479**	.428**
Cognitive Skills	.515**	.725**	.704**	.759**	1.000	.453**	.321*
TLT Writing Fall 89	.561**	.461**	.438**	.479**	.453**	1.000	.749**
TLT Writing Spr. 90	.459**	.372**	.423**	.428**	.321*	.749**	1.000

An attempt was made to assess differences between TLT students and non-TLT students in student attitudes toward school using the Heath Word List. In spite of the fact that care was taken to find synonyms for difficult descriptors, the instrument was found to be inappropriate for this age group.

Discussion

Relationship of *TLT* to Similar Studies

The 1989 "Computers in Education" survey conducted by Becker for the International Association for the Evaluation of Educational Achievement (1990) shows the emergence of word processing as a major focus of computer-based learning activity in American schools. The TLT project also had word processing as a major focus but, unlike most schools, the emphasis was on using this application to improve the quality of student writing.

Findings of this evaluation study indicate that in spite of the methodological concerns that are inherent in the study, students who were involved in the TLT program for a three-year period showed greater improvement in writing quality than their peers in non-TLT classrooms when a stringent repeated measures design was used to compare mean scores on the writing samples of the two groups. In fact, the differences between the means became greater with each year in the program. This result is consistent with the work of D'Amico (1990), who cautions that one year is not enough time for computer innovations in the classroom to show an impact.

A number of researchers (Martin, 1988; Heibert, Quellmalz & Vogel, 1990; Kell, Harvey & Drexler, 1990; Schofield & Verbon, 1988) emphasize that technology alone does not change schools or how teachers teach. Most frequently educators adapt computers to their traditional way of teaching rather than modifying their teaching methods to take advantage of the potential of the technology. Technology can serve as the catalyst for dynamic change in the classroom; it does not create the change. Technology can be used to support a vision for school improvement and restructuring that already exists, if the vision is one that is shared by teachers and supported by organizational conditions. In the case of the TLT project, there was a vision shared by the administration, the teachers, and the school. This was reflected in the initial proposal for participation in the project. Through the project, the administration at the district and school levels and the intermediate school district, Oakland Schools, worked together to arrange conditions that were conducive to the successful implementation of the technology-rich environment. The research cited above has implications for how Oakland Schools works with local districts. It is important to recognize that there must be a vision for change at the district and building levels, if change is to occur. The vision influences both how Oakland Schools staff work with the district and the organizational level at which they should be involved for greatest impact.

Financial Investment

Both Oakland Schools and Huron Valley made considerable financial investments in the Teaching and Learning with Technology project. The classrooms were provided with adequate equipment and software, training and support were readily available, and teachers were empowered to use the assets as they deemed appropriate to enhance the learning of their students. This is not the general case when innovations are introduced into schools. It was, however, deemed a valuable learning investment from several perspectives. There were more learning outcomes than technology outcomes for students. There is value in doing action research in depth in one school and/or district that can be transferred to other schools and districts. In order to facilitate such transfer, more attention needs to be paid to the processes and mediating variables that influence the implementation of technology-related programs.

Instructional Staff Variables

Of particular importance in further studies is the influence of the teacher on program outcomes. Specifically, how much of the difference between the treatment and control groups is due to the teacher versus the treatment? This is a difficult question to answer. In the TLT project, it is obvious that the teachers who were experienced computer users were ready to implement the innovation into their teaching. In their cases, having abundant technology permitted them to give more responsibility for learning to students because they saw students as having powerful tools with which to work. Their jobs became ones of structuring the learning environment to enable students to use the tools at their disposal to meet curricular goals and objectives. Their classrooms became more student-centered and project-oriented. The teachers became facilitators of learning rather than "sages on the stage." They seem to have broken the pattern of bending the technology to their teaching styles and modified their instructional delivery to take advantage of the power of the computer. Was this the result of knowing and having experienced the power of the computer for themselves? Was it based upon their prior experience? Was it because they were exceptional teachers? Teasing out the answers to these questions was not possible in this program evaluation.

The third teacher was a novice computer user and needed time to learn about the innovation. With greater familiarity came more use and greater flexibility in use. This is a normal progression in level of use of an innovation (Hall, 1974). After three years this teacher has not changed her approach to teaching. Perhaps that is normal. The other teachers did not change their teaching approaches with three years experience; they entered the program as experienced computer users. The change occurred when this experience was combined with adequate/abundant equipment and support. Is it possible that the third teacher is on the threshold of a major change in teaching style? That

possibility alone warrants the continuation of support and observation of the TLT project. Is the formula for success a teacher with a certain number of years experience, plus adequate/abundant equipment and support of the district at all levels?

A second variable that is of importance in future studies is "support" for the teachers. What kinds of support are important? Are staff development activities enough? The TLT teachers would probably respond to this question with a resounding "No." They identified the fact that they had resource people to whom they could turn for assistance as being a primary means of support. They had instant access to experts to whom they felt comfortable in turning for help. They also had common goals, established in team meetings, that provided direction and structure to their work. They were empowered by the faith and trust they felt their administration and Oakland Schools had in them. All of these are important (Gall & Renchler, 1985). It will be important for the district to take a closer look at "support" for teachers as they implement computer/writing labs in other schools within the district. Will the same kinds of support be available? Will these same support services be appropriate as teachers deal with the ambiguity of the change cycle?

Resulting Factors of Interest

In the early days of computer use in classrooms, researchers seemed rather astonished to find that one outcome of "one computer-thirty students" was increased socialization through peer tutoring and cooperative learning. That was the result of needing to share scarce resources. In the TLT classrooms the same results occurred because of a change in educational philosophy on the part of teachers. Students assisted each other and worked cooperatively on projects in which they all had a stake. They developed leadership skills and the ability to use their initiative and creativity to reach common goals. This concurs with the findings of Cochran-Smith who states, "Using word processing for writing in individual classrooms is a practice that is social as well as technical. The ways that word processing is used, the social organization of classroom learning environments, and the goals and strategies of individual teachers and students are interactively related." The interesting observation is that this result seems to be transparent to students. They do not mention the cooperation and working together that they do as a result of their TLT experience. They do not recognize that this will be a major area of change when they enter a more traditional class at the middle school level.

Communication patterns between teachers and students changed, also. Teachers became "helpers" rather than "directors;" they became "facilitators of learning" instead of "sages on a stage." Thus, the psychological distance between teachers and students decreased. This is part of the changed view teachers had of students as being capable and as

having powerful tools that permitted them to take greater responsibility for their own learning.

Sometimes educators question the ability of students to use technology effectively in elementary school. This project verifies the fact that children have the capacity to use technology in a learning environment. What is important is the mindset of both students and teachers; they must see students as capable. When this is the case and appropriate opportunities are provided, students will learn. Moreover, students who use technology in a project-oriented, interdisciplinary classroom, achieve at least as well as students who focus on various content areas singly. They didn't miss anything; district testing indicates that the students didn't suffer because of the change that occurred in their learning environment.

Education goes beyond test scores. What did the TLT project with its technology-rich environment provide for students and teachers that would not otherwise have been available to them? Both teachers and students regained the wonder of learning. The project was an opportunity for them to experiment in many areas—class structure, interdisciplinary teaching and learning, cooperative learning. Students had instant access to technology permitting them to act immediately when creative thoughts were sparked rather than delaying response to, and possibly losing, the thought. Thus, technology in this setting freed students to be creative, set their own pace and collaborate on a variety of subjects.

Conclusions

The Teaching and Learning with Technology project positively influenced the teachers and students in the project, the school district's view of the role of technology in the curriculum and the support provided by Oakland Schools to districts experimenting with technology innovations.

The technology-rich environment impacted teaching and learning. Interviews with district administrators and TLT teachers about this impact reinforced the following points:

- Using technology lends itself to doing a wide variety of tasks and projects.
- Technology opens the door for more interdisciplinary teaching and learning.
- Technology enables a process and project approach to teaching and learning.
- When technology is used, students become the center of the learning/teaching process.
- Students are empowered by technology and given responsibility for their own learning.

- Technology use motivates all classroom participants to be both teachers and learners.
- Technology opens new ways to think about teaching and learning and fosters the use of research in the classroom.

Curriculum development can be more profitable when a combined top-down -- bottom-up approach is utilized. Curriculum development is an on-going process that can occur from the elementary school up and from classroom teachers to curriculum administrators. The TLT project influenced the district writing curriculum and the district's technology plan by focusing the implementation of writing labs in the elementary schools of the district. In addition, the kinds of staff development and on-going support that is being provided to teachers as the writing labs are being implemented is an outgrowth of the TLT experience. TLT teachers are serving as trainers and they are intimately involved in the development and support of the technology support system being put into place in the district.

The intermediate school district has an important role to play as consultant to districts as they integrate technology into their curricula. This role is not just a role for technology coordinators, but must be a jointly supported effort with curriculum specialists. It is critical that the use of technology be in a context that supports the core curriculum of the school. Teachers did benefit from the support of their local school district staff and external consultants (e.g. intermediate school district consultants). As a result of TLT, Oakland Schools has included this data in its planning of consultative services.

For more information

If you would like to learn more about TLT or would like to receive the executive summary of this project report or project videotape, contact: Janet Van Dam, Coordinator, Computing & Technology, Division of Information Resources, Oakland Schools, 2100 Pontiac Lake Road, Waterford, Michigan 48328-2735; (313) 858-1996.

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Appendix A

TLT Informal Student Interview

What is your name?

How old are you?

What is your favorite subject in school?

Do you have a computer at home?

(If yes) What brand of computer is it?

Do you remember when you first used a computer?

(If yes) When was it?

(If yes) Do you remember what you used it for?

How many years do you think you have been using a computer?

What have you used a computer for?

Exit Interview Questions

1. What is your name?_____

2. What is your favorite subject in school? Why?

3. What is your least favorite subject in school? Why?

4. Do you have a computer at home?

   a. What brand of computer is it?

   b. What do you use the computer for at home?

   c. Can you name some of the computer programs you use at home?

5. Do you remember when you first used a computer?

   a. When was it?

   b. Where was it?

   c. Do you remember what you used it for?

6. What do you use the computer for at school?

7. Can you name some of the computer programs you use at school?

8. Do you think using a computer has changed the way you work in school? If so, how?

9. How do you think you would be working if you had not had a computer in school?

10. What is your job as a student in school?

11. What is the job of a teacher in school?

Appendix B

California Achievement Test Forms E & F

CAT E correlated with CAT C .69 to .82

Validity: CAT E & Test of Cognitive Skills
Intercorrelation Coefficients and Related Summary Data
(in Scale Score Units)

Level 15, CAT E Level 2 TCS
Grade 5 N = 521

	Vocabulary	Reading Comprehension	Total Reading
Sequences	.53	.52	.55
Analogies	.51	.51	.53
Memory	.50	.45	.49
Verbal Reasoning	.60	.58	.61
Total Scale Score	.66	.64	.68

Level 15, CAT E Level 3, TCS
Grade 5 N = 744

	Vocabulary	Reading Comprehension	Total Reading
Sequences	.54	.53	.56
Analogies	.50	.46	.50
Memory	.52	.51	.55
Verbal Reasoning	.73	.68	.74
Total Scale Score	.71	.67	.73

Reliability:

Kuder-Richardson Formula 20

Level 15, Grade 5

	Fall		Spring	
	KR-20	SEM	KR-20	SEM
Vocabulary	.93	2.92	.94	2.72
Comprehension	.94	2.94	.95	2.75
Total Reading	.97	4.13	.97	3.85

Test of Cognitive Skills

Validity:

Correlated with California Achievement Test (CAT)

LEVEL 15, CAT/C - LEVEL 2, TCS
Grade 5 N = 715

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		VARIABLE	MEAN	S.D.
.82	.94	.68	.66	.78	.78	.49	.71	.68	.86	.78	.54	.54	.53	.56	.64	1	READING VOCAB	467	56.1
	.96	.68	.69	.81	.81	.54	.73	.70	.89	.73	.58	.57	.53	.58	.66	2	READING COMPRE	477	66.9
		.63	.71	.83	.83	.54	.76	.71	.91	.75	.58	.58	.56	.60	.68	3	TOTAL READING	465	61.1
			.59	.65	.67	.45	.59	.58	.73	.59	.39	.33	.43	.43	.46	4	SPELLING	509	70.6
				.72	.91	.56	.71	.70	.82	.70	.54	.51	.42	.52	.59	5	LANG MECHANICS	518	57.6
					.94	.52	.75	.70	.89	.74	.57	.56	.52	.58	.66	6	LANG EXPRESSION	504	67.1
						.57	.79	.75	.92	.77	.60	.58	.51	.59	.67	7	TOTAL LANGUAGE	502	64.8
							.68	.90	.74	.56	.45	.45	.39	.46	.50	8	MATH COMPUTATION	458	58.6
								.93	.90	.74	.60	.55	.49	.56	.65	9	MATH CMPTS & APP	454	66.9
									.90	.72	.57	.55	.49	.53	.63	10	TOTAL MATH	451	62.8
										.81	.63	.61	.57	.62	.71	11	TOTAL BATTERY	458	68.9
											.56	.52	.48	.55	.62	12	REFERENCE SKILLS	488	61.1
																	TCS TESTS		
											.75	.58	.69	.88		13	SEQUENCES	517	121.9
												.54	.68	.90		14	ANALOGIES	513	136.8
													.57	.75		15	MEMORY	551	99.7
														.86		16	VERBAL REASONING	525	118.4
																17	TOTAL SCALE SCOR	526	99.8

LEVEL 15. CAT/C - LEVEL 3, TCS
Grade 5 N = 673

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		VARIABLE	MEAN	S.D.
.79	.92	.68	.62	.73	.73	.43	.67	.63	.82	.68	.49	.43	.41	.63	.58	1	READING VOCAB	472	52.0
	.96	.65	.66	.79	.79	.49	.73	.70	.88	.74	.55	.46	.40	.65	.61	2	READING COMPRE	485	63.6
		.66	.68	.80	.80	.49	.74	.70	.90	.76	.55	.47	.43	.67	.63	3	TOTAL READING	471	59.2
			.62	.63	.67	.48	.59	.61	.75	.59	.44	.34	.33	.50	.48	4	SPELLING	510	71.6
				.71	.90	.58	.68	.71	.82	.70	.54	.43	.33	.57	.55	5	LANG MECHANICS	521	58.0
					.94	.52	.70	.69	.87	.74	.56	.46	.38	.63	.60	6	LANG EXPRESSION	508	64.9
						.59	.75	.76	.92	.77	.59	.48	.38	.65	.63	7	TOTAL LANGUAGE	506	64.1
							.62	.88	.73	.53	.42	.31	.28	.42	.40	8	MATH COMPUTATION	455	47.3
								.91	.88	.75	.62	.50	.38	.62	.63	9	MATH CMPTS & APP	460	46.7
									.90	.72	.58	.46	.33	.60	.59	10	TOTAL MATH	456	41.2
										.81	.63	.51	.41	.69	.67	11	TOTAL BATTERY	463	47.0
											.59	.47	.35	.60	.60	12	REFERENCE SKILLS	491	59.9
																	TCS TESTS		
												.71	.42	.71	.86	13	SEQUENCES	528	115.8
													.47	.71	.89	14	ANALOGIES	505	139.9
														.50	.70	15	MEMORY	566	107.5
															.87	16	VERBAL REASONING	526	99.7
																17	TOTAL SCALE SCOR	531	96.5

BEST COPY AVAILABLE

Correlated with Short Form Test of Academic Aptitude
Earlier Version TCS

LEVEL 3, SFTAA - LEVEL 2, TCS
Grade 5 N = 539

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	VARIABLE	MEAN	SD
															SFTAA SCORES		
.36	.39	.62	.92	.44	.82	.98	.45	.80	.36	.32	.44	.42	.47	.49	1 VOCABULARY RAW SCORE	12.8	5.0
	.46	.36	.39	.85	.69	.39	.82	.66	.46	.35	.26	.34	.51	.51	2 ANALOGIES RAW SCORE	13.9	3.7
		.37	.42	.84	.70	.44	.83	.69	.48	.42	.29	.36	.48	.50	3 SEQUENCES RAW SCORE	12.9	3.4
			.87	.43	.78	.83	.41	.74	.35	.31	.39	.38	.44	.44	4 MEMORY RAW SCORE	9.4	4.1
				.48	.89	.97	.48	.86	.39	.36	.46	.45	.58	.52	5 LANGUAGE SCALE SCORE	449	70.9
					.81	.49	.97	.79	.54	.56	.32	.48	.58	.58	6 NONLANGUAGE SCALE SCOR	502	60.0
						.88	.88	.96	.53	.52	.47	.56	.62	.64	7 TOTAL SCALE SCORE	464	57.3
							.54	.98	.45	.48	.58	.49	.56	.61	8 LANGUAGE IQ	102	13.6
								.84	.58	.59	.37	.44	.62	.67	9 NONLANGUAGE IQ	108	13.6
									.57	.55	.51	.54	.67	.72	10 TOTAL IQ	105	12.7
															TCS SCORES		
										.67	.43	.61	.84	.83	11 SEQUENCES SCALE SCORE	550	101.8
											.44	.59	.87	.84	12 ANALOGIES SCALE SCORE	552	127.2
												.47	.78	.78	13 MEMORY SCALE SCORE	554	90.3
													.81	.78	14 VERBAL REASONING SC SR	555	86.9
														.98	15 TOTAL SCALE SCORE	553	82.4
															16 COGNITIVE SKILLS INDEX	102	14.8

LEVEL 3, SFTAA - LEVEL 3, TCS
Grade 5 N = 577

2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	VARIABLE	MEAN	SD
															SFTAA SCORES		
.45	.47	.62	.92	.54	.84	.98	.54	.81	.47	.45	.45	.66	.64	.65	1 VOCABULARY RAW SCORE	12.6	5.0
	.49	.42	.48	.86	.74	.46	.83	.70	.51	.37	.27	.48	.60	.57	2 ANALOGIES RAW SCORE	13.3	3.8
		.46	.58	.85	.75	.51	.85	.75	.61	.49	.48	.53	.65	.66	3 SEQUENCES RAW SCORE	12.1	3.7
			.86	.51	.79	.84	.58	.77	.45	.43	.42	.37	.60	.59	4 MEMORY RAW SCORE	8.9	4.0
				.57	.98	.98	.57	.88	.51	.49	.48	.68	.68	.69	5 LANGUAGE SCALE SCORE	444	70.2
					.86	.57	.98	.84	.65	.61	.39	.58	.72	.71	6 NONLANGUAGE SCALE SCOR	489	63.6
						.89	.85	.97	.64	.62	.49	.72	.79	.78	7 TOTAL SCALE SCORE	455	60.8
							.61	.91	.52	.48	.47	.68	.68	.73	8 LANGUAGE IQ	102	13.4
								.87	.65	.59	.39	.59	.71	.74	9 NONLANGUAGE IQ	105	14.2
									.64	.60	.48	.72	.78	.82	10 TOTAL IQ	104	13.3
															TCS SCORES		
										.55	.42	.57	.82	.81	11 SEQUENCES SCALE SCORE	547	98.2
											.34	.51	.80	.76	12 ANALOGIES SCALE SCORE	535	113.2
												.44	.69	.68	13 MEMORY SCALE SCORE	574	91.5
													.79	.79	14 VERBAL REASONING SC SR	548	84.2
														.97	15 TOTAL SCALE SCORE	551	75.4
															16 COGNITIVE SKILLS INDEX	102	14.8

Reliability:

Kuder Richardson Formula 20

	KR-20	SEM
Sequences	.90	1.58
Analogies	.86	1.65
Memory	.84	1.91
Verbal Reasoning	.82	1.79

Appendix C

Word Check List

Check (√) every word that you believe describes your school. If you hesitate about checking a word, do not check it. Work as rapidly as you can. Circle the number of each word that you do not check but wish that you could have checked about your school. Do not both check and circle the same word. Do not be concerned about being inconsistent. Your first impressions will generally be the most reliable ones.

1. academic/brainy
2. accepting
3. adaptable
4. adventurous
5. aggressive/hostile
6. alert
7. ambitious
8. amusing
9. anticipates consequences/ sees the results of actions
10. apathetic/unconcerned
11. argumentative
12. artistic
13. assertive
14. authoritarian/controlling
15. autonomous/independent
16. aware
17. awkward
18. boring
19. calm
20. can make decisions
21. can say no
22. capable
23. caring
24. cautious
25. changeable
26. cheerful
27. clear thinking
28. common sense
29. competitive
30. completes plans
31. conforming/follows the crowd
32. conscientious
33. conservative/careful
34. considerate
35. consistent
36. contented
37. cooperative
38. courageous
39. creative
40. critical
41. curious
42. dedicated
43. deep ethical (moral) sense/honest even when others aren't looking
44. deep interests
45. defensive
46. demanding
47. dependent
48. determined
49. difficult
50. disorderly
51. dissatisfied
52. dictatorial/bossy
53. distractable
54. doesn't care
55. dull
56. easy going
57. effective
58. efficient/productive
59. energetic
60. enthusiastic/bubbling over with excitement
61. evasive/misleading
62. excellence
63. expressive
64. fair-minded
65. feels for others
66. feminine
67. flexible
68. friendly
69. fulfilling
70. fun
71. generous

72. gentle
73. genuine
74. giving
75. good-natured
76. happy
77. hard working
78. helpful
79. honest
80. humorless/not funny
81. humorous/funny
82. illogical/doesn't make sense
83. imaginative
84. impatient
85. impersonal
86. impractical
87. impulsive/hasty
88. inconsiderate/unkind
89. inconsistent
90. independent
91. individualistic/free thinking
92. inflexible
93. inhibited/held back
94. initiative
95. insightful/clear understanding
96. integrated/smooth flowing
97. integrity/honesty
98. intellectual
99. intellectually interesting
100. intellectually rigorous/hard
101. intense
102. irresponsible
103. joyful
104. lacks energy
105. lacks self-confidence
106. leisurely/easy-going
107. liberal/open-minded
108. logical/sensible
109. lonely
110. loving
111. masculine
112. moody
113. natural
114. needs approval
115. not afraid to complain
116. not easily impressed
117. open
118. optimistic/upbeat
119. orderly
120. outspoken
121. passive/unemotional
122. perfectionistic
123. persistent/determined
124. personal
125. pessimistic/always sees the bad side of things
126. plans ahead
127. playful
128. plays it safe
129. practical/sensible
130. precise
131. proud
132. purposeless/without meaning/spacy
133. put downs
134. realistic
135. reasonable
136. rebellious/uncontrollable
137. reflective/thoughtful
138. relaxed
139. religious
140. resourceful/clever
141. responsible
142. restless
143. rigid/unchangeable
144. sarcastic/insulting
145. scheduled
146. self-centered
147. self-confident
148. self-conscious
149. self-controlled
150. self-educated
151. self-motivating
152. self-reliant
153. self-respect
154. sensitive
155. show-off
156. sincere honest
157. social
158. sophisticated/worldly-wise
159. spontaneous/spur-of-the-moment
160. stable

161. strong convictions/
beliefs/ideas
162. strict
163. stubborn
164. suspicious
165. sympathetic/caring
166. talkative
167. thinks of others
168. thorough
169. traditional
170. trusting
171. uncritical of others/accepts
others as they are
172. understanding
173 unemotional
174. unfair
175. unfeeling
176. unhappy
177. uptight
178. verbal/spoken
179. warmth
180. well-informed
181. worrying

Appendix D

TLT Teacher Survey

1. Please check the technologies you have used during the past year in your class.

_____ a.	video	_____ b.	telecommunications
_____ c.	microcomputer	_____ d.	videodisc
_____ e.	CD ROM		

2. Briefly describe how you use each of the technologies you checked in question 1.

3. How many years experience do you have with computers? _____

4. How many years have you used computers in the classroom? _____

5. What software packages do you and your students most frequently use?

6. What criteria do you use to evaluate the effectiveness of using technology to meet classroom (curricular) objectives?

7. Briefly describe a lesson that meets those criteria.

8. Briefly describe the staff development programs provided as part of the TLT project.

9. Using your 20/20 hindsight, which staff development experiences do you consider critical to your success with the TLT project?

10. Has using technology, especially computers, altered the way you teach? If yes, how? Please reflect on changes that have occurred over the three years of the project.

11. How has the TLT project influenced curriculum in Spring Mills Elementary School and throughout the district?

Name _____

Teacher Survey - (Non-TLT Teachers)

1. Please check the technologies you have used during the past year in your class.

_____ a.	video	_____ b.	telecommunications
_____ c.	microcomputer	_____ d.	videodisc
_____ e.	CD ROM		

2. Briefly describe how you use each of the technologies you checked in question 1.

3. How many years experience do you have with computers? _____

4. How many years have you used computers in the classroom? _____

5. What software packages do you and your students most frequently use?

6. What criteria do you use to evaluate the effectiveness of using technology to meet classroom (curricular) objectives?

7. Briefly describe a lesson that meets those criteria.

8. Has using technology, especially computers, altered the way you teach? If yes, how?

9. Has having the TLT project in your school affected your thinking and behavior in regards to using technology in the classroom? If yes, please check the ways it has impacted upon you.

_____ a. Use the computer more often to meet curricular objectives
_____ b. Use the computer to prepare class assignments
_____ c. Use the computer as a gradebook
_____ d. Have taken computer training/workshops offered by the district or Oakland Schools
_____ e. Have taken computer classes for graduate credit
_____ f. Teaching is more interdisciplinary
_____ g. Other (please explain)

10. Assuming that money and time are no object, describe your personal professional development plan for the next two years.

Name _____

Appendix E

REPEATED MEASURES
ANALYSIS OF VARIANCE
BETWEEN TLT AND NON-TLT CLASSES
ON THE WRITING TEST
FOR THREE YEARS

Writing	Mean		S.D			Sig.
Scores	TLT	Non-TLT	TLT	Non-TLT	F	of F
Fall 87	7.857	7.500	13.417	5.066	.00268	.959
Sp 88	9.238	8.750	3.064	3.775	.07985	.780
Fall 88	6.333	5.750	2.153	2.500	.23602	.632
Sp 89	9.143	8.250	3.021	2.986	.29432	.593
Fall 89	12.286	9.750	3.566	5.188	1.48312	.236
Sp 90	14.143	8.750	3.321	2.630	9.31342	.006

N for TLT = 21
N for Non-TLT = 4

REPEATED MEASURES
ANALYSIS OF COVARIANCE
FOR TWO YEARS
(FOURTH AND FIFTH GRADES)

Writing	Mean		S.D			Sig.
Scores	TLT	Non-TLT	TLT	Non-TLT	F	of F
Fall 88	6.500	6.600	2.241	2.171	.01395	.907
Sp 89	9.409	8.400	3.202	2.591	.76171	.390
Fall 89	12.182	9.400	3.514	3.718	4.15997	.050
Sp 90	14.273	9.800	3.298	3.553	12.06588	.002

N for TLT = 22
N for Non-TLT = 10

Appendix F

ANALYSIS OF COVARIANCE BETWEEN TLT AND NON-TLT CLASSES ON THE GATES MacGINITIE READING LIST

	1987-88	1988-89	1989-90
Third Grade			
Vocabulary	F=0.082	0.055	0.538
Comprehension	F=0.099	2.067	0.058
Total Score	F=0.097	0.722	0.101
Fourth Grade			
Vocabulary	F=0.924	11.322**	1.644
Comprehension	F=1.300	2.815	2.865
Total Score	F=0.995	5.651*	0.115
Fifth Grade			
Vocabulary	F=0.138	missing data	0.062
Comprehension	F=0.903	missing data	1.334
Total Score	F=0.404	missing data	1.524

* pL.05
**pL.01

Appendix G

Teaching and Learning with Technology
Case Studies, 1989-90

Three or four students from each of the three grades in the project were singled out for close attention during the course of the year. The eleven students selected represent a range of abilities and attitudes toward learning and technology. The purpose of the case studies was to provide another way of observing and evaluating what was happening in these classrooms. The case studies help to humanize the notions we develop about the project based on test results and descriptions of classroom activities. As always, case studies are most useful for the questions they raise and the issues they help define.

Third Grade

Student A. *October*. This low-achieving student is lovable and eager to please. He wants to do well to the point of tears when he doesn't succeed. He may have a reading disability (like his father) and is under the tutelage of the BEST committee for a possible learning problem. He completes assignments and always tries. One of the parents is temporarily not living at home.

December. IQ 90. He continues to be a hard worker and does excellent work with the *Type to Learn* program. He still has trouble with reading and spelling, but he is comfortable with the computer. When using the computer, he works hard to see projects to completion.

May. He continues to show progress and has become a wizard with *Type to Learn*. Although still handicapped, he has shown improvement in reading and writing. His teacher feels he has made all possible growth. The computer may have helped. He is still reluctant to story-write, however, though what he writes now is less chaotic and makes more sense.

What is most interesting about this student is that his lack of creativity and ability enables him to master the *Type to Learn* program the more able and creative students find boring. This rather rigid, but interactive, program invoked his tenacious spirit. The absorption in language that the program demands must certainly have played a role in his improved reading and writing during the year. It's important to note that the computer seems not to have made him more creative or prolific (as it does with most other students), but it may have helped to keep him more focussed and provided him an opportunity to excel, to be more encouraged in and recognized for his keyboard skill.

Student B. *October*. This typical middle-level student does what is expected of her but no more. She is not committed; she is careless; she does not reach beyond. She is nevertheless capable, sweet, and eager to please.

December. She is still typical and average—unfocused, short attention span. She will do what needs to be done but is indifferent to the quality of her work—high ability, low effort. She is very sociable. For her, computer time is social time—time to interact with others. She is a file-jumper, someone who starts and tinkers with many files but finds it difficult to reach closure. There have been times when she would become so exhausted by trying out different versions of the title for a prospective story that she would save the title, close the file, and move on to something else.

May. She has shown improvement and growth in both reading and writing and has become more task-oriented at the computer. Although she now gets her stories done, she is still not a "go beyond" person. She enjoys using the computer and displays good computer aptitude and keyboard skill. She is eager to provide assistance to others, and this application of her sociability to the academic program may have kept her more focussed than she otherwise would have been.

Naturally, a student's growth from October to May of the third grade is attributable to many complex influences, and the computer is certainly one of them. The influence of the computer on this student is in contrast to its influence on Student A above. For him, the narrow limits of an interactive drill-and-practice program have liberated him from discouragement. For student B, the public and social nature of writing in a computer-rich classroom provided a way to bring the student and the person together. This is a student who thrives on collaboration and was disciplined into productivity by the demands of peers.

Student C. *October*. Like other members of his large family, this boy is bright, inquisitive, and a quick learner bored by the established curriculum and by drill. He is given extra reading in preparation for a video book report. He would be happy with more computer access. Three pupils sharing a computer is too many for him.

December. It all comes easily. He is always on task and has high writing skills. He is always helpful to others on peer editing and shows great warmth and kindness in doing peer work.

May. Still a high achiever who has mastered the computer. Very high writing skills and admirable peer tutor. He is an effective problem-solver and trouble-shooter with computer programs. He enthusiastically welcomes new software and masters the programs quickly and with ease.

This is the student every teacher wants. Most students are helped by the computer in some way, but students who are very bright may be helped in a way that is out of proportion to other students. Although that did not prove to be a problem in this particular case, it is not

difficult to imagine situations in which a computer-rich environment could exacerbate existing differences in ability between students in the classroom.

Fourth Grade

Student Q. *October*. This is "Mr. Computer." He relates poorly with his classmates, lacks patience, and is pugnacious. But he relates well with the computer as a thing over which he has mastery. We will be watching the social and interpersonal influence of computing here—does the computer desocialize this boy? Does the effort to set up collaborative groups help counter this tendency? Academically, he is an average student who knows more than he shows.

December. He is a visual learner who comprehends computing at the highest levels. Nevertheless his reputation as a school yard and neighborhood bully have made him a social outcast. He has no trouble with authority and seems to empathize with the teacher's role. Still, he is highly defensive when cornered with accurate reports of his behavior, and the selective memory of his defenses carries over into situations where there is no need for defensive behavior. The teacher has assigned him extra responsibility appropriate to his exceptional computing ability. According to the teacher: "He reorganized disks according to their owners' design, and explains how to use them afterward. This job presents [student Q] with two challenges: 1) most kids are reluctant to let him work on their disks, and 2) he has to pay attention to his job well enough to explain it to his 'customers.'" These social and cognitive tasks have forced him to smooth out his interpersonal relationships within the framework of his special skills. He has learned that there are many students with whom he can work, and he knows how to steer clear of those whom he finds incompatible, though he can work with them when required.

May. He has blossomed. His teacher, who is himself exceptionally skillful with computers, considers student Q to be his equal on technical matters such as anticipating and solving problems. More important, however, has been his stunning breakthrough in socialization by learning how to be a valuable resource to peers.

The wisdom of the teacher's intervention in this case should remind us of the obvious; that computers will not displace good teachers.

Student R. *October*. This student has poor language skills, and she works by plodding. Yet on the computer she excels, producing a large volume of work in short order. But she lacks confidence in general and avoids anything new, preferring endless replications of the routines in *Children's Writing and Publishing Center* to moving on to new kinds of work. She has a shaky grasp on facts.

December. Continues to do well on the tried and true while avoiding new challenges. She has unpredictable highs and lows, but working on a long story on the computer seems to raise her spirits.

May. Her growth has been slow but consistent, and she has become a good writer. During the last quarter of the year she reverted to a lower-grades mentality, but in her better moments she volunteered to write difficult and challenging articles for the class news magazine, and she adapted well to *AppleWorks* when it replaced *Magic Slate* as the standard word processor. Somewhere, somehow she managed to overcome the tendency to merely repeat what was easy.

For a student subject to highs and lows brought on by unknown influences, the attentiveness demanded by the computer seems to neutralize conflicting emotions and anxieties. For this student, working on the computer seemed to have the same kind of salutary effect as having a new friend.

Student S. *October*. This student prefers paper and pencil and resists using the computer. She works in slow motion and seems to take forever to get a few words entered from the keyboard. She is excellent in math and low to average in reading, making it hard to evaluate her general ability and to account for her indifference to using the computer. She has a great need for friendly communication and seems to know more than she shows.

December. Although she is very good at telling stories, her written versions, whether pencilled or word processed, are brief and sketchy. And she is very slow getting work done. Although she is personable and friendly, she seems to shun the kind of collaborative interaction that the public nature of video display invites. She seems too shy and uncomfortable with herself to commit writing to a form that can be read and commented on by passersby.

May. She is still a reluctant user of computers and much prefers the paper and pencil mode. The only possible attraction of the computer is its capacity to check spelling, one of her weaknesses. She continues to be very slow and absolutely cannot be rushed. She is perhaps the only student in the three classes involved in this project to be utterly unaffected by the computers. This is not because of any personality or learning defect. It is therefore useful to note that some students will simply not be interested in or affected by the speed, focussing power, or socializing influence of computers.

Student T. *October*. This is a quiet and bright student identified by the school district as gifted and talented. He gets high scores in math and reading and works best when interested. He takes pride in being ahead and impressing teachers and classmates, plunging into every opportunity for advanced computing. Since he grasps everything the

first time, he becomes ostentatiously inattentive when material is repeated. Will he burn out? There are signs of his occasional reaction against academic excellence.

December. Like Student Q, who has haunted by his reputation for playground violence, student T is dogged by his reputation as an exceptional student to the extent that displays of excellence are no longer impressive but expected. Thus, when T is put in charge of the computer with a hard disk and extra memory, becomes resident expert on *AppleWorks*, facilitates file transfer and desktop publishing, and learns how to operate telecommunications software, his teacher is pleased, to be sure, but not particularly impressed. In order to be impressed, the teacher will expect T to master the challenge of the cooperative learning group where T's determination to have his own way brings him into conflict with other students reacting against his smug superiority.

T has been assigned the role of facilitator, which forces him to rise above the rightness or wrongness of his own viewpoints and assure the successful outcome of group efforts. The teacher reports progress. T's intellect has helped him see beyond himself, and as a facilitator he has found the way to truly impress. Once again, the teacher's analysis of the situation and his intervention help to place computer expertise firmly within the contest of the social dynamics of the classroom.

May. T's interests continue to expand, and he now prefers collaborative work. The socializing effect of his role as group facilitator has been impressive, and he has been able to expand the horizons of his partners, who are willing and eager to work with him— a superior student in every way and one whose superiority rests not only on computer and other forms of academic expertise but putting that expertise to effective use.

Fifth Grade

Student W. *October*. This low-achieving student actually prefers writing to reading. His expressive and oral language is quite good, but he lacks experience with the written conventions of language and feels uncomfortable in that mode. The youngest child of older parents, he spends much time in the company of older adults, which may have provided him with a repertoire of interesting things to say. He has trouble rereading his own writing and now sometimes works in long hand. He produces interesting invented spelling.

December. He has become more comfortable using the computer, and this may have helped him be more adventurous in starting new topics. He has made progress in planning his writing, and he actively seeks help and advice from peers. He makes many more starts than finishes, which is to be expected in word processing, and this ability to at least get started must surely be a sign of growth.

May. He has an improved attitude toward writing and feels more comfortable doing it. Nevertheless, he continues to have problems with technical and mechanical skills. The thoughts are there, but the problem of execution lingers. He has gradually become more at ease using the computer, but compared to other students he has been slow to adapt. After all, this group of fifth graders has been using computers since the middle of third grade. Student W is one who may have been helped by the computer only marginally—but that small margin is important to him.

Student X. *October*. This top student is a year older than his classmates and very mature and bright. She is strongly language oriented and uses words in a mature and sophisticated way. Though she is not good in math, she is very good with the computer. She is also content to work by hand when necessary. Because she does not get along well with her classmates, she has ended up with her own computer. She does good collaborative work, though she tends to be harsh in her judgements and bossy in her dealings with other students.

December. She has been experimenting with poetry and recognizes and appreciates the power of words. She enjoys word play and has developed the kind of fluency that enables her to write on demand quickly and effectively on any subject. This ability has made her a valued contributor to the class newspaper. Her editing skills are outstanding.

May. She has become the class editor by acclamation, her harsh and bossy manner to some extent modified by her own efforts and accepted by her classmates. Her writing continues to be creative and fluent, and she has deep reserves from which ideas and poems flow easily. She has become a more sophisticated observer of people. For a student like her the computer provides an outlet for creativity that will come out sooner or later. The computer, and the environment in which it is used, may help bring it out sooner.

Student Y. *October*. This middle to high fifth grader has a huge knowledge base and benefits from a remarkably retentive memory. He is ready with answers to all questions. He does a lot of collaborative work and has not produced enough individual written work to enable his teacher to judge his writing. His parents were concerned about a possible reading disability, which runs in the family, but there is definitely no reading problem. Nevertheless his memory is more retentive of oral than of written information.

December. Though a good collaborative worker, he is more inclined to work independently. He is another who makes many more starts than finishes. Indeed, he gets easily interested in a whole range of subjects and possibilities. Though he does all work on the computer, even it can't keep up with all he wants to say and do.

May. His work has flattened out, perhaps because of the isolation imposed by his independent work habits. He has tremendous ideas and great sensory input, but what he develops is so egocentric and complex that he cannot follow through. The immense difficulties of the tasks he undertakes wear him out, and he stops putting effort into projects. He is trying to run while still only able to walk. This difficulty in reaching closure seen in Y and others may be exacerbated by the computer's ability to encourage input and multiply files.

Student Z. *October*. This at risk student gets extra work in the resource room on reading. But she loves the computer and works on it whenever she has a chance. She has difficulty following oral directions. Her writing is about as good as it can be given the interference of her problems with reading.

December. The computer continues to play a vital role in this student's development. She is a constant user and has been particularly skillful with graphics. She eagerly takes on any new assignment or other task on the computer. This has probably helped her reading because she is no longer required to do extra work in the resource room.

May. She is comfortable not only with the computer but with her much improved communication skills. Indeed, she is the most improved writer in the class by far. Her teacher describes her growth as "astounding."

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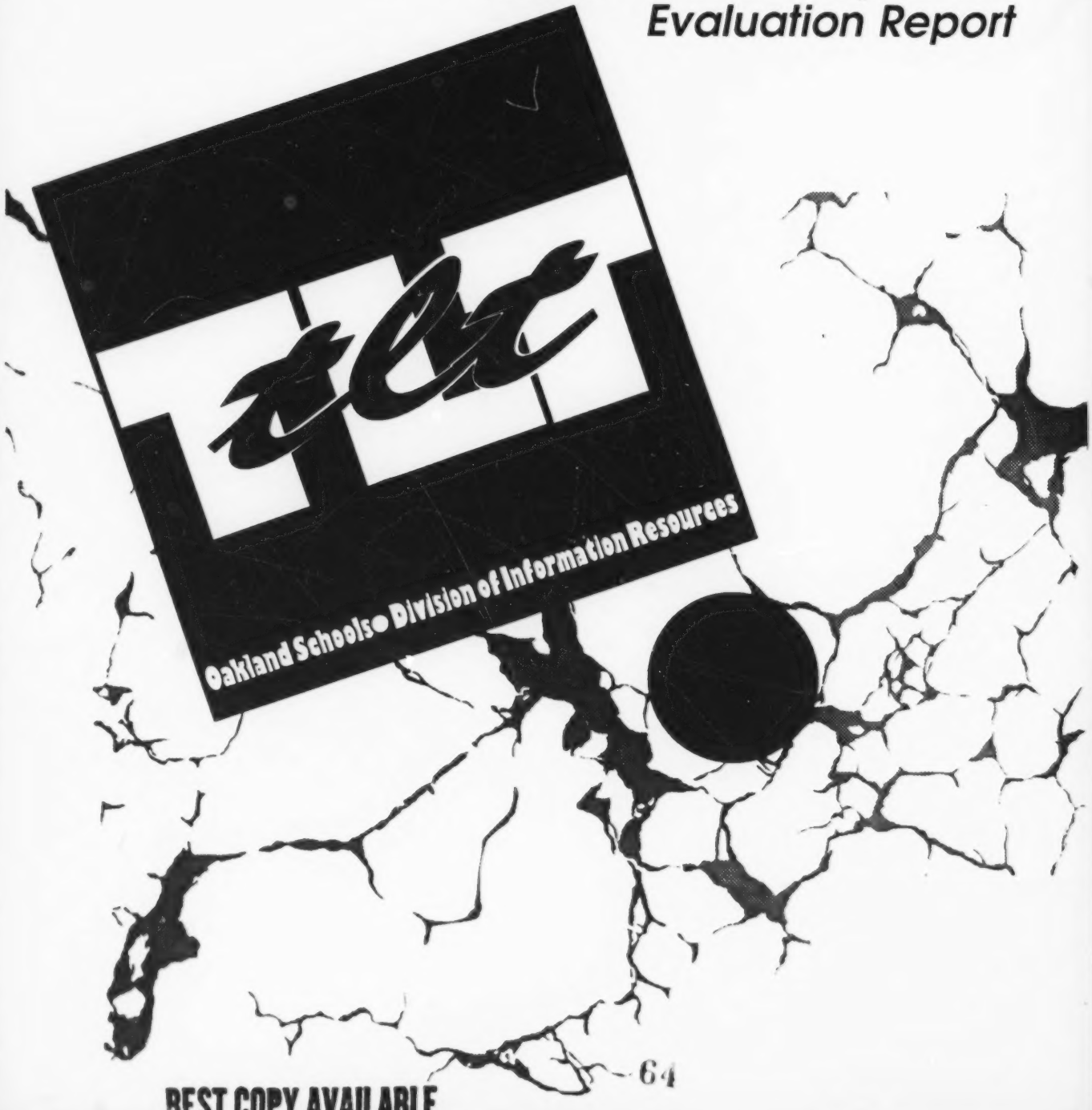
Teaching and Learning with Technology

Executive Summary of the Evaluation Report



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Teaching and Learning with Technology

Executive Summary of the Evaluation Report

Prepared by
Division of
Information Resources
Oakland Schools
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Teaching and Learning with Technology

Executive Summary of the Evaluation Report

The Teaching and Learning with Technology Project was funded by Oakland Schools in 1987 to bring together in an elementary school those technologies that will be key components of schools in the future with an instructional program designed to prepare students for the information age. Spring Mills Elementary School in the Huron Valley School District was identified as the site for a pilot project that would enable personnel from both the local school district and Oakland Schools to accomplish the following three objectives:

- explore and identify appropriate classroom applications for technologies such as microcomputers, instructional television, videodiscs, CD ROM, and telecommunications;
- design staff development programs that result in the effective use of technology to accomplish curricular objectives; and
- study the impact of technology on teaching and learning.

Project Description

The initiating agency for the Teaching and Learning with Technology Project was Oakland Schools, an intermediate school district serving the 28 local school districts within Oakland County Michigan. As a cooperative endeavor of the language arts and the computing and technology groups, the major emphasis of the instructional program was to be the use of word processing in writing.

The Huron Valley School District, in the western part of Oakland County, is a rapidly developing area. Initially a farming area centering around the town of Milford, it is now a region of new home developments and overcrowded schools. Spring Mills School, built in 1975, is designed for the open spaces concept with wall-less classrooms clustered around centrums, open areas that can be used for large group activities. Students in the school are mainly drawn from the local housing developments, but at a distance that requires transportation to be provided.

Begun in Fall 1987, the project focused on third, fourth and fifth grade classrooms within Spring Mills Elementary School. One classroom at each level was identified and equipped with microcomputers to serve as a technology-rich environment. A technology-rich environment was defined as a classroom that had a two-to-one student to computer ratio at the fourth and fifth grade levels and a three-to-one student to computer ratio at the third grade level with classroom access to videodisc players, video, CD-ROMs, and telecommunications.

In addition to the creation of technology-rich environments, staff development was an integral part of the project design. It had seven components:

- a keyboarding workshop;
- computer software and videodisc demonstrations;,
- a writing consultant in residence;
- semi-annual workshops on change facilitation;
- monthly team meetings;
- regular and special technology-related training sessions sponsored by Oakland Schools; and
- county-wide discussions related to the role of technology in school restructuring.

Third grade teacher Carol Wagers confers with project writing consultant Ron Sudol, a professor at Oakland University.

Having established the technology-rich environments in the three classrooms and provided training in keyboarding, the teachers exercised leadership in determining effective means of using the technology in the instructional program. Support was provided as needed and direction/ structure was arrived at collaboratively in team meetings. The staff at Oakland Schools acted in a facilitative role so as to observe the changes in teaching and learning that might occur in this new environment while being responsive to teachers' needs.

Project Evaluation

In Spring 1990 the first group of students to complete three years in the TLT program graduated to middle school. The evaluation of the program was conducted with a primary focus on this first three-year TLT cohort while including information obtained from students over the past three years who were in the program less than three years.

Questions and subquestions posed for the study of the Teaching and Learning with Technology Project included:

1. In a technology-rich environment, how is the technology applied to enhance educational goals?

   a. What technologies and software/technology-related instructional materials are used in the classroom?

   b. How are these technologies used in the classroom to meet curricular objectives?

   c. How effective is the application of technology to the writing process in improving student writing?

2. What kinds of staff development programs result in the effective use of technology to accomplish curricular objectives?

   a. How much training in the use of the various technologies is necessary? What methods seem most effective? What do teachers need to know?

   b. How has the TLT project influenced the local district's staff development program?

   c. How has the TLT project influenced the curriculum of the Huron Valley School District?

   d. What has Oakland Schools learned about staff development for teachers in a technology-rich environment that will enable its staff to provide better services to other teachers/districts in Oakland County?

3. What is the impact of a technology-rich environment on teaching and learning?

   a. How does teaching style change when a teacher moves from a technology-poor to a technology-rich environment?

   b. How does a teacher's role in the classroom differ in a technology-rich environment from a teacher's role in a technology-poor environment?

Jim Phipps and his fourth graders cluster around work stations to review progress on a project.

Fifth grade teacher Bill Devers conferences with students regarding their writing.

c. What knowledge and skills do teachers report gaining as a result of being in a technology-rich environment for the past three years?

d. How does being in a technology-rich environment affect teacher attitudes?

e. Does being in a technology-rich environment increase students' achievement test scores as measured by a standardized test?

f. Does being in a technology-rich environment enhance students' reasoning skills?

g. How does being in a technology-rich environment affect student attitudes toward school and peers?

Methodology

To determine the difference technology can make on student achievement, reasoning and attitudes, this study combined an inferential approach with classroom observation, interview data and self-report to reveal the characteristics of the teaching-learning process in technology-rich environments. Particular emphasis was placed on achievement in writing.

Findings

How Technology Is Applied to Enhance Education Goals

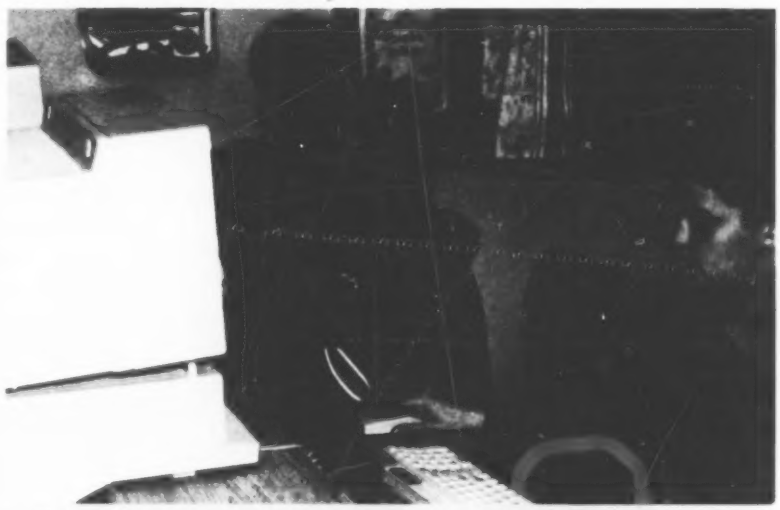
Comparisons between treatment and control classrooms indicated that there are differences between the two types of classrooms on the following variables: 1) amount of technology available, 2) the number of technologies used, and 3) the way technology is used to meet curricular objectives.

Technology-rich classrooms had a two-to-one student to computer ratio at the fourth and fifth grade levels and a three-to-one student to computer ratio at the third grade level. In addition, they had available to them the following technologies: video, videodisc and computer-assisted telecommunications.

Teachers and students in these classrooms employed their technology assets in a variety of ways to meet curricular objectives. In third grade emphasis was placed upon students developing keyboarding skills and using word processing for writing assignments. The use of word processing was expanded in fourth grade. Fourth graders used their microcomputers in other ways. They participated in AT&T's Long-Distance Learning Network communicating via telecommunications and they engaged in desktop video production. Videodisc was introduced as an integral part of the learning environment. Students in fifth grade used their computers as tools to meet curricular objectives in a variety of ways: writing, database project management, inquiry learning, desktop publishing, telecommunications, simulations, and programming in Logo. They produced periodic newsletters, participated in the AT&T Long Distance Learning Network and carried out a variety of projects, including a cross-age project with kindergarten students.

Differences in writing quality between the TLT and non-TLT students were assessed each year. Comparisons between the groups were made using a repeated measures design. The results indicated that while the groups were similar when they entered the program in third grade, they became more disparate each year with significant differences ($F(1,23) = 9.31$, $p < .006$) appearing at the end of fifth grade.

Students work in self-directed groups.



Comparisons of how students in the technology-rich and technology-poor environments use computers indicated that there was a significant difference between the two groups' use of computers in school ($x^2(13) = 54.19$, $p < .001$), but no difference between the groups' use of computers outside of school. TLT students reported the almost exclusive use of computers for writing and other applications (graphics, telecommunications) in school. The non-TLT students placed more emphasis on the use of computers to reinforce basic skills. At home both TLT and non-TLT students used computers about equally for writing and playing games.

A pretest-posttest comparison of TLT students' uses of computers at school indicated a dramatic shift from *games*, or drill and practice types

of programs, to the use of applications software where the computer was used as a tool to accomplish specific tasks; i.e. writing, illustrating, telecommunicating (x^2 (10) = 33.8, $p < .001$).

Effects of Staff Development on Curricular Objectives

Training needed for successful classroom implementation of technology. Three aspects of the staff development program were considered critical to the success of the project: structure, direction and support. These were acquired through team meetings which engendered the feeling that TLT teachers enjoyed the trust of Oakland Schools and local district personnel. They felt empowered.

Technology-related training was important to the TLT teachers, but not sufficient. They reported that training they received in instructional skills development (Instructional Theory Into Practice or ITIP) and on the Michigan Definition of Reading contributed to their success in the technology-rich environment. This training provided a context into which they could incorporate the use of technology to further curricular objectives.

Students readily tie computers into the curriculum.

TLT influences on the district's curriculum and staff development. The TLT project caused the school district to re-focus on its writing program and its long-range technology plan. Word processing is now viewed as a tool that can assist students to communicate and express their ideas creatively. A computer/writing laboratory is being established in each elementary school to foster this use of technology.

The top-down organizational structure that usually enacts curriculum change has been reversed. Changes are being influenced by what teachers are doing in the classroom.

While TLT teachers serve as trainers when the computer/writing laboratories are installed, there is a recognition of the additional need for teacher support in this endeavor. Teachers within the TLT project found it valuable to share ideas, set common goals and assist each other when technical problems arose. This support network now extends to other teachers within the school and district. The TLT project empowered the teachers as change agents and they are working with other change agents to achieve common goals.

Implications for staff development at the intermediate school district level. Because support for change at the school and district level and a support network for teachers are important components of staff development, there are implications for where and with whom intermediate school district consultants interact in a local district.

Technology will not change a teacher. It will, however, frequently make a good teacher better because it revitalizes both the teacher and the profession. Technology is a tool for the teacher; its value is in what the teacher brings to it and how it is used as a tool of instruction. Growth can be facilitated by technology as it is integrated into instruction. For this to occur a support network is vital.

Students take a more active part in learning, using their teacher as a resource.

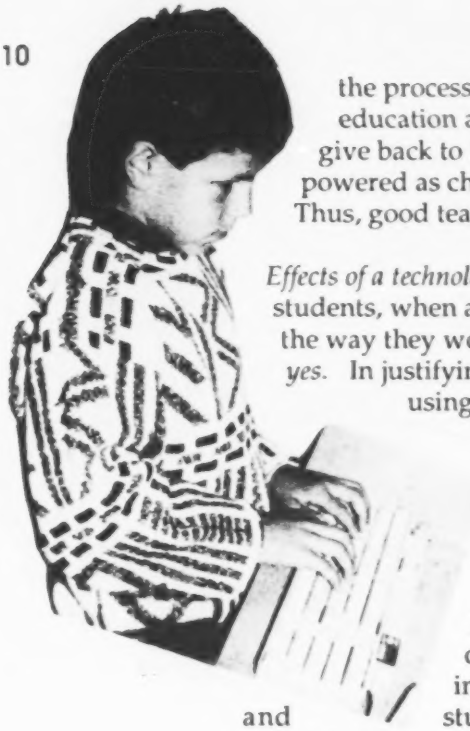
The intermediate school district may serve a vital role in assisting teachers to broaden the context for using technology; emphasis of classes should be placed upon how and where technology can be used in the curriculum rather than on learning about technology as an end in itself.

Local school districts have and will benefit from collaborating with an intermediate school district when the effort is focused and consultant expertise is brought to bear in the district over a prolonged period of time.

Impact on Teaching and Learning

Effects of a technology-rich environment upon teaching and teachers. The project teachers report that they do not want to teach without technology. They see computers as powerful tools that have provided the opportunity for a different kind of structure to evolve in their classrooms. They can be omnipresent without being controlling. They see students as having more power and more responsibility for their learning and, thus, they expect students to identify and solve problems more independently.

Changes in teacher behavior mirror changes in skills and attitudes. In addition to learning more about technology and ways it can be integrated into the curriculum, teachers report that they and their students have a greater tolerance for ambiguity and that both parties have ownership in the teaching/learning process. The project forced conscious discussion of their roles as teachers causing them to take stock of themselves and their work. Consequently, they are more reflective about what they do in the classroom and seek out research to learn more about



the process of education. They have gained a broader view of education and have acquired skills and knowledge they can give back to the profession. The TLT teachers have been empowered as change agents with children and their colleagues. Thus, good teachers have been enabled to become better teachers.

Effects of a technology-rich environment upon learning and students. TLT students, when asked whether they think computers have changed the way they work in school, were almost unanimous in responding *yes*. In justifying their responses they cited their preference for using a word processor versus writing with a pencil. They found it easier to write and draw, to correct errors, to be more productive, and to improve their writing skills. They saw the computer as a tool that they can control and apply to a variety of tasks.

The social environment of the TLT classrooms changed over the course of the project. Extensive interactions among students and between teacher and students in the TLT classrooms are a normal part of doing business. Students generally work with computer partners. Their writing is on public display and invites comments from classmates who *just happen by*. Projects are conducted in cooperative groups. The result is students who exhibited leadership in a number of ways—they worked cooperatively with others, they were better prepared for work when they came to class and they were more self-directed.

Today's technology rich classroom affords us a glimpse at the classroom of tomorrow and its opportunity to substantively change the process of schooling.

Students in the non-TLT classrooms were split in their responses about whether the computer has changed the way they work in school. They saw the computer more as a delivery system that could provide instruction and improve skills than as a tool they could use for their own personal productivity.

Conclusions

The Teaching and Learning with Technology project positively influenced the teachers and students in the project, the school district's view of the role of technology in the curriculum and the support provided by Oakland Schools to districts experimenting with technology innovations.

Increased time on task assisted students personal productivity.

The technology-rich environment impacted teaching and learning. Interviews with district administrators and TLT teachers about this impact reinforced the following points:

- using technology lends itself to doing a wide variety of tasks and projects;
- technology opens the door for more interdisciplinary teaching and learning;
- technology enables a process and project approach to teaching and learning;
- when technology is used, students become the center of the learning/teaching process;
- students are empowered by technology and given responsibility for their own learning;
- technology use motivates all classroom participants to be both teachers and learners; and
- technology opens new ways to think about teaching and learning and fosters the use of research in the classroom.

Curriculum development can be more profitable when a combination of top-down -- bottom-up approach is utilized. Curriculum development is an on-going process that occurs from the elementary school up and from classroom teachers to curriculum administrators. The TLT project influenced the district writing curriculum and the district's technology plan by focusing the implementation of writing labs in the elementary schools of the district. In addition, the types of staff development and on-going support being provided to teachers as the writing labs are being implemented is an outgrowth of the TLT experience. TLT teachers are serving as trainers and they are intimately involved in the development and support of the technology support system being put into place in the district.

The schooling process has changed in the TLT classrooms providing evidence for replication in other learning environments.

The intermediate school district has an important role to play as consultant to districts as they integrate technology into their curricula. This role is not just a role for technology coordinators, but must be a jointly supported effort by curriculum specialists. It is critical that the use of technology be in a context that supports the core curriculum of the school. Teachers did benefit from the support of their local school district staff and external consultants (i.e. intermediate school district consultants). As a result of TLT, Oakland Schools has included this data in its planning of consultative services.

For more information.

If you'd like to learn more about TLT or would like to receive the complete project report or project videotape, contact: Janet Van Dam, Coordinator, Computing & Technology, Division of Information Resources, Oakland Schools, 2100 Pontiac Lake Road, Waterford, Michigan 48328-2735; (313) 858-1996.

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